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Comparative Toxicity of Some Pesticides to *Tetranychus urticae* Koch and two Phytoseiid Mites

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ABSTRACT

The toxicity of nine insecticides (carbosulfan, chlorepyrifos ethyl, cypermethrin, deltamethrin, deltamethrin + dimethoate, dimethoate,diflubenzuron, and teflubenzuron), and six fungicides (carbendazim, chlorothalonil, difenoconazole, hexaconazole, kresoxim methyl, and penconazole) to two phytoseiid predatory mites: *Neoseiulus fallacies* German and *Typhlodromus cotoneastri* Wainstein was evaluated in laboratory, by spraying leaves discs. The toxicity of tested pesticide-residues that showed high toxicity to the predators in spraying method was also evaluated. Results showed that fungicides; carbendazim and kresoxim methyl, were non toxic to the tested predators, hexaconazol and chlorothalinol were slightly toxic; while difenoconazole and pencocanazole were moderately toxic. For insecticides: deltamethrin was non toxic to phytoseiid mites, emamectin benzoate and diflubezuron were slightly toxic, cypermethrin and tiflubenzuron were moderately toxic, whereas carbusolfan, dimethoate, chlorepyrifos ethyl, and dimethoate + deltamethrin were highly toxic. As for the toxicity of pesticide-residues, the toxicity of cypermethrin, diflubezuron, and teflubezuron decreased to become slightly toxic when the predators were placed on the leave-discs just after the pesticides were dried out, whereas the toxicity of carbusolfan, chlorepyrifos ethyl and dimethoate did not decrease until 48 hrs passed after application. The toxicity of the insecticide to *T. urticae* varied, it ranged from non toxic (diflubenzuron) to highly toxic (chlorepyrifos ethyl, cypermethrin, dimethoatee, diltamethrin + dimethoatee, deltamethrin, and emamectin benzoate). The toxicity of tested fungicides to *T. urticae* was almost the same of their toxicity to phytoseiid mites: it ranged from non-toxic to moderately toxic.

Key Words: Apple, Insecticides, Fungicides, Toxicity, Phytoseiidae, *Tetranychus urticae*.

INTRODUCTION

The two spotted spider mite *Tetranychus urticae* Koch and European red mite *Panonychus ulmi* Koch are key pests of apple orchards (Talhouk, 1969; Al-Abdulla, 2001; Halloum and Qerhaili, 2008). These mites cause serious damage (Bondarenko et *al*., 1987; Kasap, 2004, Abdel-wali et *al*., 2012). Some authors mentioned that in unsprayed apple orchards, phytophagous mites usually are under permanent control by predators (Van de Vrie, 1985), because chemical pest control frequently causes outbreak spider mites population. This undesirable side effect is partly because of spider mites ability to build up resistance rapidly to the most used acaricides, cross resistance (Beers et *al*., 2005; Toyoshima, 2003) and destroying natural enemies populations which would control these mites (Metzeger, 2001, Nadimi et *al*., 2011).

The relative importance of destruction natural enemies has been recorded in many field trails. In Ohio, USA, sulphur applied three times to control powdery mildew in apple orchards showed to be incompatible with the biological control of *P.ulmi* by *Zetzelia mali* (Ewing) and *Agistemus fleschneri* (Summers) (Bostanian and Larocque, 2001). In Northern Ireland, mancozeb and captan might reduce predatory mite numbers (Cuthbertson and Murchie, 2003), also in New York, USA, mancozeb ,which was used to control apple scab, reduced the number of *Typhlodromus pyri* Scheuten when applied four times in the growing season, but its toxic effect was reduced when it was applied just two times during the growing season (Berth, 2002).

Ecological selectivity for natural enemies can be achieved by manipulation the pesticide formulation, method of application, and other means (Croft, 1990), in addition to use pesticides that are effective against target species and simultaneously relatively harmless to non- target beneficial arthropods (Cuthbertson and Murchie, 2003).

So, the main purpose of this study was to examine the toxicity of the pesticides commonly used in apple orchards in order to find selective pesticides that are least detrimental to the native phytoseiid mites in these orchards.

MATERIALS AND METHODS

Nine insecticides and six fungicides were tested in this study (Table1). These chemicals are commonly used in fruit orchards in Syria.

Laboratory tests: Populations of *T .urticae* and the two Phytoseiid predators: *Neoseilus fallacies*

Garman and *Typhlodromus cotoneastri* Waistein were collected from apple orchards from Permmant El-Masheik- Tartous, and Shakrieh- Lattakia, and reared in the laboratory on bean leaves. The toxicity tests were conducted on the two phytoseiid species together because of the difficulty of distinguishing between them, which needed longer time than toxicity tests allowed.

All tests were conducted on the second generation of the spider mites, under laboratory conditions (25±2ºC, 50-60%R.H.). Adult females of spider mites were transferred to apple leaf discs (3cm in diameter) ,then placed on moist cotton pads in plastic Petri-dishes (9cm in diameter). Each pesticide and control treatments were replicated five times (10 females/ replicate). Mites were sprayed with the tested pesticides using a hand sprayer, and mites of control treatment were sprayed with water only.

Mortality was recorded after 24 hrs.of treatment. Corrected mortality was calculated according to Abbott's formula (Abbott, 1925).

The selectivity factor between *T. urticae* and phytoseiid mites was evaluated according to the formula: Selectivity factor of a pesticide= its toxicity to *T. urticae*/ its toxicity to Phytoseiid mites (Suchrechenko and Tolstova, 1990).

For the determination of quantitative toxicity categories, we applied those adopted by the International Organization for Biological Control for toxicity assessment to predatory and phytophagous mites in field trails: non toxic(<25 mortality), slightly toxic (25-50%), moderately toxic (51-75%), highly toxic (>75%) (Hassan et *al*., 1985).

The toxicity residues of pesticides which were highly toxic to the phytoseiid mites in the spraying method were tested, by placing the spider mites on treated leaf discs after: just drying, 24 hrs, and 48 hrs.

The numbers of *T. urticae*, and Phytoseiid predators among the treatments were compared among treatments in this study with the single factor analysis of variance (ANOVA).

RESULTS AND DISCUSSION

The data (Table 2) revealed that, after 24 hours of treatment, deltamethrin was non toxic to predatory mites (mortality was 5%), both emamactin benzoate and diflubenzuron were slightly toxic to phytoseiid mites (mortality averaged 37.5 and 45 % ,respectively), but carbosulfan, chlorepyrifos ethyl, dimethoatee, dimethoatee + deltamethrin were highly toxic to phytoseiid mites (mortality recorded 87.5, 97.5, 100, 100% ,respectively).

The toxicity of these insecticides to *T. urticae*, after 24 hours of treatment, were different: diflubenzuron was non toxic (mortality was 15%), deltamethrin was slightly toxic (mortality was 45%), both carbosulfan and teflubenzuron were moderately toxic (70.27 and 60 % mortality, respectively), but chlorepyrifos ethyl, cypermethrin, dimethoate, deltamethrin+ dimethoate, deltamethrin, and emamectin benzoate were all highly toxic to *T. urticae* (97.5, 90, 100, 100, 100 % mortality, respectively) (Table 2).

The highest number in selectivity factor for insecticides was for deltamethrin, although it was slightly toxic to *T.uticae*, but its toxicity to the last was nine times as its toxicity to the predatory mites. Emamectin benzoate came after deltamethin (2.68), then cypermethrin (1.24), and teflubenzuron (1.09). The selectivity factor of the other insecticides was (1) or less, which meant that their toxicity to phytoseiid mites were the same as their toxicity to *T. urticae*. (Table 2)

For the toxicity of fungicides to phytoseiid mites; both carbendazim and kresoxim methyl were non-toxic (22.5 and 25% mortality, respectively), chlorothalinol and hexaconazole were slightly toxic (35 and 40% mortality, respectively), whereas difenoconazole and penconazole were moderately toxic (52.5 and 55 % mortality, respectively). All fungicides were nontoxic to *T. urticae* (Table 2). However, the toxicity of each fungicide for phytoseiid mites was almost the same being almost one for all fungicides.

Data in Table 3 showed that cypermethrin, diflubenzuron, and teflubezuron were slightly toxic to phytoseiid mites when the last were placed on treated discs just after drying (mortality recorded 38.88, 44.44, and 50%,respectively). Carbosulfan, chlorepyrifos ethyl, and dimethoatee were highly toxic to phytoseiid mites just after drying (mortality averaged 77.77, 94.44, and 91.16%, respectively), after 24 hours of treatment. Tthese three insecticides became moderately toxic (mortality were 52.5, 60, 55 % respectively), and after 48 hours the toxicity reduced to become slightly toxic (38.46, 46.55, 28.21 % mortality, respectively). The selectivity factor for fungicides less than one, which meant that their toxicity for phytoseiid mites were higher than their toxicity to *T. urticae*, except for carabendazim and hexaconazole

Table1. Active ingredient%, formulation type and concentration rate of the tested pesticides

	Trade name	Active ingredient% and formulation type	concentration rate (ml or g/ 1L water)
Insecticides			
Carbosulfan	Caster	250 EC	140
Chlorepyrifos ethyl	Dolan	480 EC	200
Cypermethrin	Supermethrin	25 EC	0.20
Deltamethrin	Dinamethrin	50 E C	0.25
Deltamethrin+ Dimethoat	Destil D	1.25 + 40 EC	0.60
Dimethoate	Agri Thoate	40 EC	0.15
Diflubenzuron	Dimilin	25WP	0.60
Emamectin benzoate	Contact	50 WDG	0.25
Teflubenzuron	Nomolt	15SC	0.66
Fungicides			
Carbendazim	Defazeem	500WP	0.50
Chlorothalonil	Cloupes	75 WP	2.00
Difenoconazole	Lord	250EC	0.40
Hexaconazole	Hexazol	5 EC	0.40
Kresoxim methyl	Strubil	50 WG	2.00
Penconazole	Domino	100 EC	0.50

Table (2): Toxicity of the tested pesticides to *T .urticae* and phytoseiid mites after 24 hours in laboratory

Pesticides	Mortality %		Selectivity factor
	T.urticae	Phytoseiids	
Insecticides			
Carbosulfan	70.27Ba	87.5Ab	0.80
Chlorepyrifos ethyl	97.5Ab	97.5Aa	1
Cypermethrin	90Bc	72.5Ac	1.24
Ddeltamethrin	45Bd	5Ad	9
Deltamethrin+ dimethoat	100Ab	100Aa	1
Dimethoat	100Ab	100Aa	1
Diflubenzuron	15Be	45Ae	0.33
Emamectin benzoate	100Bb	37.5Am	2.68
Teflubenzuron	60Aa	55As	1.09
Fungicides			
Carbendazim	30Ba	22.5Aa	1.33
Chlorothalonil	25aBb	35Ab	0.71
Difenoconazole	24.32Bab	52. 5Ac	0.46
Hexaconazole	42.5Ac	40Ab	1.06
Kresoxim methyl	22.5Ab	25Aa	0.9
Penconazole	21.62Bb	55Ac	0.39

Means with the same small letter in the column are not significantly different (P=0.05).
Means with the same capital letter in the line are not significantly different (P=0.05).

Table (3): Toxicity of the residues of the tested pesticides to phytoseiid mites

Pesticides	Mortality % after:		
	Just drying	24 hours	48 hours
Carbosulfan	77.77c	52.5a	38.46a
Chlorepyrifos ethyl	94.44a	60b	46.55b
Cypermethrin	38.88b	-	-
Dimethoate	91.16a	55ab	28.21c
Diflubenzuron	44.44be	-	-
Teflubenzuron	50e	-	-

(-) no readings because the pesticide was already slightly toxic.
Means with the same letter in the column are not significantly different (P=0.05).

which their selectivity factors were 1.33 and 1.06, resepectively. (Table 2).

The present results showed that carbosulfan, chlorepyrifos ethyl, and dimethoate were highly toxic to phytoseiid mites in direct spraying of insecticides or placing them on the treated discs just after drying, but they became safer when the phytoseiids were introduced to the treated discs after 48 hours of application. Previous studies indicated that carbosulfan was highly toxic to the predatory mite *Amblyseius longispinosus* Evans when placed on treated discs (Kongcheunsin and Takafuji, 2006), and to *Neoseiulus fallacis* German (Pratt and Croft, 2000). The toxicity chlorepyrifos ethyl to phytoseiid mites, varied in the literature; according to a Bulletin OEEP/EPPO it was non- toxic to *Phytoseiulus persimilis* A.-H., highly toxic to *Typhlodromus occidentalis* Nesbitt, *Amblyseius andersonii* (Cant) and *N. fallacis* (Pratt and Croft, 2000; James., 2004). There were differences in references about toxicity of dimethoate to phytoseiid mites too. Many of them indicated that dimethoate was highly toxic to *T. occidentalis*, *N. fallacis*, and *A. andersonii* (New England apple pest management, 2006; James , 2004), but other studies revealed that it was non toxic to *P. persimilis* (Brun et *al*., 1983; Oomen et *al*., 1991).

The results showed that cypermethrin was moderately toxic by direct spray. Its toxicity was moderately when the tested predators were placed on treated discs just after drying. This disagrees with other studies which indicated that it was highly toxic to *N.longispinosus* (Evans) (Kongcheunsin and Takafuji, 2006), *P. persimilis* (Oomen et *al*., 1991), and *N. fallacis* (Bostanian and Larocque, 2001).

Deltamethrin was the safest pesticide within the tested pesticides herein. In France in vein orchards a resistant strains of *A. andersonii* and *T. pyri* appeared (Hardman et *al*., 2000).

Diflubenzuron and tiflubenzuron (insect growth regulators) were slightly to moderately toxic to phytoseiid mites in different methods of treatments in the present study, whereas other studies showed that they were non toxic to *P. persimilis* (Oomen et *al*., 1991), and to *Galendromus helveolus* (Cant) in citrus orchards in Texas (Chen et *al*., 2003).

For fungicides; carbendazim was non-toxic to phytoseiid mites as previous bioassays showed that carbendazim was non-toxic to *N. longispinosus* (Evans) (Kongchuensin and Takafuji, 2006,), but it was highly toxic to *T. pyri* and *Amblyseius potenttillae* (Garman)(Hassan et *al*., 1987).

Both chlorothalonil and hexaconazole were slightly toxic to phytoseiid mites; while kresoxim methyl was nontoxic. This agrees with previous tests on *N. fallacis* (Metzeger, 2001; Bostanian and Larocque, 2001). Penconazole in our bioassays was moderately toxic to phytoseiid mites. This disagrees with the Bulletin OEPP/EPPO (1991) which indicated that penconazole was non toxic to *P. persimilis* A.-H., but Mansour et *al* (1993) found that this fungicide was highly toxic to *Typhlodromus athiasae* Porath & Swirski in apple orchards.

In conclusion, our bioassay results revealed that none of the previous pesticides was distinctly highly selective between *T. urtica* and phytoseiid mites, except for deltamethrin and emamectin benzoate. On the other hand; if it is necessary to use pesticides in orchards where phytoseiids are present in the Syrian coastal area, it is advisable to use deltamethrin, diflubenzuron, and emamctin benzoate, which did not reveal toxicity to the predatory mites. For fungicides, their rate of toxicity to *T. urticae* was almost similar to their toxicity to phytoseiid mites.It ranged from non-toxic to moderately toxic. So it is safe to use the tested fungicides in apple orchards even if the phytoseiid mites are present.

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